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Abstract or Summary: The Lower Elkhart River is listed on the 303(d) list of impaired waterbodies for *Escherichia coli* (*E. coli*). The sampling events over the thirty days confirmed that the Lower Elkhart River is impaired and exceeds the WQS based on the 125 cfu/100mL geometric mean for the bacteria *E. coli.* The Lower Elkhart River will require TMDL development because of this assessment.

Keywords: Total Maximum Daily Load (TMDL), *Escherichia coli* (*E.coli),* Water Quality Standard (WQS), Geometric Mean

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Water Quality Assessment for the Development of Total Maximum Daily Loads for *E. coli* Bacteria in Lower Elkhart River, Noble and Elkhart Counties

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Attachments: ***(NOTE:THE ATTACHMENTS LISTED BELOW ARE AVAILABLE UPON REQUEST FROM THE AUTHOR OF THIS REPORT)***

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Introduction

The IDEM 1998 303(d) list of impaired waterbodies, listed Lower Elkhart River as being impaired for Escherichia coli (*E. coli)*. The water assessment monitoring survey was accomplished during the 2000 sampling season.

The Lower Elkhart River begins east of Ligonier in Noble County and flows northwest into Elkhart County until it reaches the St. Joseph River. At its confluence with the St. Joseph River, the drainage area of the Elkhart River basin is 699 square miles, of which 422 square miles are in the Lower Elkhart River basin (source: "Drainage Areas of Indiana Streams" by Richard E. Hoggatt, USGS & IDNR, 1975). There is one continuous gaging station on the Lower Elkhart River main stem; this is station #04100500, located in Goshen, Indiana. The gaging station has a total drainage area of 594 square miles and a median discharge of 389 cfs.

The largest municipal NPDES dischargers in the Lower Elkhart River are Ligonier (1.5 mgd design flow) and Goshen (12.5 mgd design flow) (See Figures 1 and 2 Elkhart River Basin and Lower Elkhart River Assessment maps).

Methods

Sampling Criteria

Only one *E. coli* sampling event (5 samples evenly spaced over a 30 day period) is necessary. There are 12 surface water locations that were sampled five times to calculate a geometric mean for *E. coli* during this initial Water Quality Assessment Survey. According to 327 IAC 2-1.5-8 (e)(2), *E. coli* bacteria shall not exceed 125 cfu per 100 ml as a geometric mean based on 5 samples evenly spaced over a 30 day period nor exceed 235 cfu per 100 ml in any one sample in a thirty day period.

The presurvey was completed on July 17, 2000. This was done to determine if the sites proposed were appropriate and able to meet the 6-hour holding time for processing and transportation to ELH Laboratories in South Bend.

The five sampling events took place starting on September 26th, and proceeded through October 25th, 2000. The water samples were collected using stainless steel buckets and transferred into 120ml plastic bottles that contained sodium thiosulfate ($Na_2S_2O_3$). Samples were stored on ice and transported to EHL Lab. Duplicate and field blanks were also collected for Quality Assurance /Quality Control. All water samples arrived at the lab within 4 hours after the sample was collected which was within the 6 hour holding time for *E.coli*.

Field Measurements

At each location, field parameter measurements were taken with a YSI^{TM} multi-parameter water chemistry sonde for pH, temperature, turbidity, specific conductance, chloride, chlorophyll and dissolved oxygen.

Deviation from the Sampling Work Plan

There was only one modification to the sampling plan and it was because the 6 hour holding time for processing was exceeded for the 10/11/00 samples.

Results

The data results of the five sampling runs are found in the three data tables. Table 1, lists the sites that violate the WQS for the geometric mean. Table 2, summarizes the *E. coli* data collected at each site. YSI Field Data is provided in Table 3.

Sites

LJM190-0015 Elkhart River, C.R 750 W., East of Ligonier
This site is the farthest upstream site that was sampled. There were two single event violations of the *E. coli* WQS, and the geometric mean for the five sampling runs also violated the WQS.

LJM190-0014 Elkhart River, N. River Rd, NW of Ligonier
This site was sampled from the bank during the five runs. There were two single event violations of the *E. coli* WQS, and the geometric mean for the five sampling runs also violated the WQS.

LJM190-0013 Elkhart River, C.R. 100 W.
There were two single event violations of the *E. coli* WQS, and the geometric mean for the five sampling runs also violated the WQS.

LJM190-0012 Stony Creek, C.R. 44
This site could be influenced from the land uses near and adjacent to Stony Creek. Cattle were observed on two occasions when water samples were collected. There was one single event violation of the *E. coli* WQS, and the geometric mean for the five sampling runs also violated the WQS.

LJM1910-0011 Solomon Creek, C.R. 33
There was one single event violation of the *E. coli* WQS, and the geometric mean for the five sampling runs also violated the WQS.

LJM190-0010 Elkhart River, C.R 142
There was one single event violation of the *E. coli* WQS, and the geometric mean for the five sampling runs also violated the WQS.

LJM200-0011 Turkey Creek, C.R. 142
There was one single event violation of the *E. coli* WQS, and the geometric mean for the five sampling runs also violated the WQS.

LJM210-0014 Rock Rum Creek, Indiana Ave., N. Side of Goshen
There was one single event violation of the *E. coli* WQS, and the geometric mean for the five sampling runs also violated the WQS.

LJM210-0013 Elkhart River, C.R. 19
This site was sampled from the bank during the five sampling runs. There was one single event violation of the *E. coli* WQS.

LJM210-0012 Elkhart River, C.R. 17
This site did not have a violation of the *E. coli* WQS during the five sampling events.

LJM210-0011 Yellow Creek, C.R. 18 or Hivel Rd.
There was one single sampling event violation of the *E. coli* WQS.

LJM210-0010 Elkhart River, E. Jackson Blvd
This site did not have any violation of the *E. coli* WQS during the five sampling events.

This site (LJM210-0010) is also listed in the St. Joseph River's *E.coli* project. The St Joseph River *E.coli* project indicated a WQS violation for the geometric mean at this site. This violation was because of a major rain event between the Lower Elkhart Project sample date (10/3/00) and the St Joseph River Project sample date (10/4/00).

Discussion

Of the twelve sites sampled for this project, there were sixteen separate violations at ten of the sites that exceeded WQS for single sampling event for *E.coli* (235 cfu per 100 milliliters). Of these ten sites, eight violated the *E. coli* WQS for geometric mean of 125 counts per 100 millimeters.

Conclusion

The following sites on the Elkhart River and it's tributaries are in violation of the *E. coli* standard based on the geometric mean as stated in 327 IAC 2-1.5-8 (e)(2), and will require TMDL development. When available, the geometric mean is the value used to make final judgement on stream water quality standards.

Table 1
Violations by Sites
***E.coli* Geometric Mean**
Results

Site Name	Description	Stream Name
LJM190-0015	C.R. 750 W.	Elkhart River
LJM190-0014	River Rd. on N. Gerber Rd.	Elkhart River
LJM190-0013	C.R.1100 W.	Elkhart River
LJM190-0012	C.R. 44	Stony Creek
LJM190-0011	C.R. 33	Solomon Creek
LJM190-0010	C.R. 142	Elkhart River
LJM200-0011	C.R. 142	Turkey Creek
LJM210-0014	C.R. 21	Rock Run Creek

Table 2
E.coli Data in CFU/100mL
for
Lower Elkhart River Project

Site Name	Surface Water Name	Sample Number	Sample Date	Lab Result (cfu)	Geometric Mean (cfu)	WQS Violation
LMJ190-0015	Elkhart River	AA01967	9/26/00	380	190	Yes / Mean
LMJ190-0015	Elkhart River	AA02310	10/3/00	130		No
LMJ190-0015	Elkhart River	AA02481	10/11/00	80		No
LMJ190-0015	Elkhart River	AA02757	10/18/00	570		Yes
LMJ190-0015	Elkhart River	AA03012	10/25/00	110		No
LMJ190-0014	Elkhart River	AA01969	9/26/00	560	227.4	Yes / Mean
LMJ190-0014	Elkhart River	AA02312	10/3/00	380		Yes
LMJ190-0014	Elkhart River	AA02483	10/11/00	140		No
LMJ190-0014	Elkhart River	AA02759	10/18/00	120		No
LMJ190-0014	Elkhart River	AA03014	10/25/00	170		No
LMJ190-0013	Elkhart River	AA01970	9/26/00	560	250.6	Yes / Mean
LMJ190-0013	Elkhart River	AA02313	10/3/00	400		Yes
LMJ190-0013	Elkhart River	AA02484	10/11/00	140		No
LMJ190-0013	Elkhart River	AA02760	10/18/00	210		No
LMJ190-0013	Elkhart River	AA03015	10/25/00	150		No
LMJ190-0012	Stony Creek	AA01971	9/26/00	470	269.1	Yes / Mean
LMJ190-0012	Stony Creek	AA02314	10/3/00	230		No
LMJ190-0012	Stony Creek	AA02485	10/11/00	290		Yes
LMJ190-0012	Stony Creek	AA02761	10/18/00	250		Yes
LMJ190-0012	Stony Creek	AA03016	10/25/00	180		No
LMJ190-0011	Solomon Creek	AA01972	9/26/00	230	135.3	Yes / Mean
LMJ190-0011	Solomon Creek	AA02315	10/3/00	80		No
LMJ190-0011	Solomon Creek	AA02486	10/11/00	100		No
LMJ190-0011	Solomon Creek	AA02762	10/18/00	820		Yes
LMJ190-0011	Solomon Creek	AA03017	10/25/00	30		No
LMJ190-0010	Elkhart River	AA01973	9/26/00	2100	194.2	Yes / Mean
LMJ190-0010	Elkhart River	AA02316	10/3/00	110		No
LMJ190-0010	Elkhart River	AA02487	10/11/00	90		No
LMJ190-0010	Elkhart River	AA02763	10/18/00	190		No
LMJ190-0010	Elkhart River	AA03018	10/25/00	70		No
LMJ200-0011	Turkey Creek	AA01974	9/26/00	230	150.9	Yes / Mean
LMJ200-0011	Turkey Creek	AA02317	10/3/00	180		No
LMJ200-0011	Turkey Creek	AA02488	10/11/00	70		No
LMJ200-0011	Turkey Creek	AA02765	10/18/00	300		Yes
LMJ200-0011	Turkey Creek	AA03019	10/25/00	90		No
LMJ210-0014	Rock Run Creek	AA01975	9/26/00	170	166.3	Yes / Mean
LMJ210-0014	Rock Run Creek	AA02318	10/3/00	1300		Yes

LMJ210-0014	Rock Run Creek	AA02489	10/11/00	30		No
Site NAME	Surface Water Name	Sampler Number	Sample Date	Lab Results (cfu)	Geometric Mean (cfu)	WQS Violation
LMJ210-0014	Rock Run Creek	AA02766	10/18/00	320		Yes
LMJ210-0014	Rock Run Creek	AA03020	10/25/00	60		No
LMJ210-0013	Elkhart River	AA01976	9/26/00	80	92.8	No
LMJ210-0013	Elkhart River	AA02319	10/3/00	160		No
LMJ210-0013	Elkhart River	AA02490	10/11/00	20		No
LMJ210-0013	Elkhart River	AA02767	10/18/00	270		Yes
LMJ210-0013	Elkhart River	AA03021	10/25/00	100		No
LMJ210-0012	Elkhart River	AA01977	9/26/00	70	82	No
LMJ210-0012	Elkhart River	AA02320	10/3/00	130		No
LMJ210-0012	Elkhart River	AA02491	10/11/00	20		No
LMJ210-0012	Elkhart River	AA02768	10/18/00	120		No
LMJ210-0012	Elkhart River	AA03022	10/25/00	170		No
LMJ210-0011	Yellow Creek	AA01978	9/26/00	130	75	No
LMJ210-0011	Yellow Creek	AA02321	10/3/00	610		Yes
LMJ210-0011	Yellow Creek	AA02492	10/11/00	50		No
LMJ210-0011	Yellow Creek	AA02769	10/18/00	10		No
LMJ210-0011	Yellow Creek	AA03023	10/25/00	60		No
LMJ210-0008	Elkhart River	AA01979	9/26/00	40	36.7	No
LMJ210-0008	Elkhart River	AA02322	10/3/00	120		No
LMJ210-0008	Elkhart River	AA02493	10/11/00	20		No
LMJ210-0008	Elkhart River	AA02770	10/18/00	-1		No
LMJ210-0008	Elkhart River	AA03024	10/25/00	70		No

Table 3
YSI Field Data

Site Name	Stream Name	Date	DO mg/L	Deg C	pH	Conductance mS/cm	Turbid NTU	% Sat.	Chloride mg/L	Chloro mg/L	Field Notes
LJM190-0010	Elkhart	9/26/00	10.8	11.6	8.17	711	11.1	99.5	135.4	5.7	
		10/3/00	11.76	16.2	8.12	655	9.9	119.1	82.78	5.9	
		10/11/00	8.38	10.3	8.2	1316	11.3	92.3	92.33	6.1	
		10/18/00	8.43	12.8	8.17	1212	13.6	80.1	59.33	9.5	
		10/25/00	9.67	16.2	7.89	1285	5.7	98.7	60	4.6	
LJM190-0011	Solomon	9/26/00	11.29	9.7	8.08	829	10.2	99.5	157	6	
		10/3/00	11.65	14.0	8.05	756	5.9	113.3	88.24	5.2	
		10/11/00	8.34	9.2	8.09	1519	11.2	73.0	99.6	5.5	
		10/18/00	10.36	10.7	8.07	1423	6.5	93.4	41.85	5.6	
		10/25/00	8.98	14.8	7.88	1454	5.3	89.6	67.55	4.4	
LJM190-0012	Stony C	9/26/00	11.19	11.4	8.14	823	8.1	102.6	140	2.6	Grazing / Pasture
		10/3/00	11.25	15.4	8.0	744	4.3	113.2	94.8	3.2	Grazing / Pasture
		10/11/00	9.17	10.0	8.14	1484	5.5	82.0	106.1	3.1	Grazing / Pasture
		10/18/00	7.93	12.5	7.9	1317	2.0	79.3	53.11	3.6	Grazing / Pasture
		10/25/00	9.38	15.9	7.8	1407	2.0	95.4	72.0	3.4	Grazing / Pasture
LJM190-0013	Elkhart	9/26/00	10.58	11.7	8.03	689	11.6	97.7	134.2	8.2	
		10/3/00	11.03	15.8	7.99	642	6.2	111.7	96.7	6.3	
		10/11/00	8.67	10.0	8.1	1276	74.3	77.0	107.7	8.5	Turbidity Suspect
		10/18/00	8.09	12.9	8.05	1176	20.8	76.9	67.33	14	
		10/25/00	9.08	16.1	7.8	1242	53	92.5	75.0	7.1	Turbidity Suspect
LJM190-0014	Elkhart	9/26/00	9.68	12.1	7.92	704	13.6	90.4	132.9	8.2	Sampled from bank
		10/3/00	11.78	16.2	7.89	654	10.8	121	103.6	7.0	Sampled from bank
		10/11/00	8.76	10.3	8.03	1290	11.8	78.2	117	8.9	Sampled from bank

YSI Field Data

Site Name	Stream Name	Date	DO mg/L	Deg C	pH	Conductance uS/cm	Turbid NTU	% Sat.	Chloride mg/L	Chloro mg/L	Field Notes
		10/18/00	10.52	13.3	8.0	1194	19.6	100.7	66.58	13.2	Sampled from bank
		10/25/00	7.7	16.0	7.75	1263	33.8	78.1	78.5	38.2	Sampled from bank
LJM190-0015	Elkhart	9/26/00	9.79	11.5	8.01	668	14	89.7	117	3.7	
		10/3/00	11.8	16.8	7.98	610	11	121.9	130.7	8.0	
		10/11/00	9.75	10.4	8.1	1235	8.1	87.8	163.2	9.3	
		10/18/00	7.97	12.7	8.06	1141	18.2	75.3	55.15	14.0	
		10/25/00	7.44	16.1	7.83	1197	17.0	75.8	95.96	13.8	
LJM200-0011	Turkey	9/26/00	11.56	10.8	8.07	841	7.6	104.8	140.7	4.4	
		10/3/00	11.64	15.3	8.04	781	4.1	116.7	83.44	3.4	
		10/11/00	8.25	10.0	8.06	1561	6.6	73.4	95.4	5.2	
		10/18/00	8.24	11.6	8.05	1491	3.2	76.2	66.32	5.3	
		10/25/00	8.85	15.5	7.83	1489	2.9	89.1	63.0	3.8	
LJM210-0014	Rock Run	9/26/00	11.38	10.9	8.23	799	6.7	103.4	143.3	3.9	
		10/3/00	12.37	15.4	8.16	715	3.4	124.3	79.73	3.2	
		10/11/00	8.27	10.3	8.24	1473	18.7	74.4	93.66	3.8	
		10/18/00	10.54	11.6	8.26	1348	2.8	96.8	56.26	5.1	
		10/25/00	9.87	16.1	8.05	1387	2.8	100.5	78.0	3.5	
LJM210-0013	Elkhart	9/26/00	11.39	13.3	8.08	779	10.0	109.0	135.0	5.4	Sampled from Bank
		10/3/00	12.27	16.6	8.09	725	5.8	131.0	92.77	6.7	Duckweed Visible
		10/11/00	8.76	11.0	8.16	1424	13.9	80.0	91.23	5.6	Sampled from Bank
		10/18/00	8.87	13.7	8.11	1312	10.4	85.9	66.84	9.1	Sampled from Bank
		10/25/00	9.16	16.4	7.92	1396	12.2	93.9	86.5	5.8	Duckweed Visible
LJM210-0012	Elkhart	9/26/00	11.44	13.2	8.1	772	8.9	109.4	138	4.2	Grazing / Pasture
		10/3/00	12.39	16.4	8.09	718	6.6	127.1	132.9	3.8	Grazing / Pasture
		10/11/00	8.73	10.9	8.18	1416	10.5	79.3	90.0	5.4	Duckweed Visible
		10/18/00	10.7	13.6	8.14	1304	10.3	97.9	64.65	7.9	Grazing / Pasture
		10/25/00	9.48	16.3	7.94	1376	9.3	96.8	94.96	5.0	Grazing / Pasture
LJM210-0011	Yellow	9/26/00	11.56	11.5	8.0	1036	9.0	106.5	168.2	3.6	
		10/3/00	12.27	15.7	7.95	942	4.4	124.1	180.0	3.4	
		10/11/00	8.16	10.4	7.99	1909	7.7	73.6	103.2	4.1	
		10/18/00	8.08	12.5	8.0	1791	4.6	76.3	113.3	5.2	
		10/25/00	9.21	16.4	7.87	1772	6.1	94.5	65.4	4.2	
LJM210-0010	Elkhart	9/26/00	12.21	13.4	8.21	781	6.8	117.4	147.0	2.9	
		10/3/00	13.41	16.8	8.22	719	3.2	138.8	188.5	3.6	
		10/11/00	8.99	11.0	8.27	1435	6.8	81.9	94.53	4.5	
		10/18/00	8.95	13.7	8.26	1341	3.2	86.7	73.75	4.2	
		10/25/00	9.47	16.3	8.01	1399	4.2	96.9	60.0	4.5	

Elkhart River Basin